

# Package ‘digiRhythm’

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**Type** Package

**Title** Analyzing Animal's Rhythmicity

**Version** 2.3

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**Description** Analyze and visualize the rhythmic behavior of animals using the degree of functional coupling (See Scheibe (1999) <doi:10.1076/brhm.30.2.216.1420>), compute and visualize harmonic power, actograms, average activity and diurnality index.

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

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ggplot2, lubridate, stringr, zoo, crayon, stats

**Suggests** knitr, rmarkdown, testthat (>= 3.0.0), usethis

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**URL** <https://nasserdr.github.io/digiRhythm/>

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actogram	<i>Plot a an single actogram over a period of time for a specific variable</i>
----------	--

---

**Description**

Takes an activity dataset as input and plot and save an actogram of the specified activity column

**Usage**

```
actogram(df, activity, activity_alias, start, end, save = "actogram")
```

**Arguments**

df	The dataframe containing the activity data
activity	the name of activity
activity_alias	A string containing the name of the activity to be shown on the graph.
start	The start day (in "%Y-%m-%d" format).
end	The end day (in "%Y-%m-%d" format).
save	if NULL, the image is not saved. Otherwise, this parameter will be the name of the saved image. it should contain the path and name without the extension.

**Value**

A ggplot2 object that contains the actogram plot

**Examples**

```
data("df516b_2")
df <- df516b_2
activity <- names(df)[2]
start <- "2020-05-01" # year-month-day
end <- "2020-08-13" # year-month-day
activity_alias <- "Motion Index"
my_actogram <- actogram(df, activity, activity_alias, start, end,
  save = NULL
)
print(my_actogram)
```

---

daily\_activity\_wrap\_plot

*Plot daily average over a period of time for a specific variable.*

---

**Description**

Takes an activity dataset as input and plot and save the daily average of the specified activity column

**Usage**

```
daily_activity_wrap_plot(
  df,
  activity,
  activity_alias,
  start,
  end,
  sampling_rate,
  ncols,
  save = "daily_wrap_plot"
)
```

**Arguments**

df	The dataframe containing the activity data
activity	the name of activity
activity_alias	A string containing the name of the activity to be shown on the graph.
start	The start day (in "%Y-%m-%d" format).
end	The end day (in "%Y-%m-%d" format).
sampling_rate	the sampling rate of the data.
ncols	the number of columns to spread the graphs on. be the name of the saved image. it should contain the path and name without the extension.
save	if NULL, the image is not saved. Otherwise, this parameter will

**Value**

A ggplot2 object that contains the daily average activity plot

**Examples**

```
data("df516b_2")
df <- df516b_2
activity <- names(df)[2]
activity_alias <- "Motion Index"
start <- "2020-05-01" # year-month-day
end <- "2020-05-07" # year-month-day
ncols <- 3
sampling_rate <- 30
my_dwp <- daily_activity_wrap_plot(
  df, activity, activity_alias, start, end, sampling_rate,
  ncols
)
```

---

daily\_average\_activity

*Plot daily average over a period of time for a specific variable.*

---

**Description**

Takes an activity dataset as input and plot and save the daily average of the specified activity column

**Usage**

```
daily_average_activity(df, activity, activity_alias, start, end, save)
```

**Arguments**

df	The dataframe containing the activity data
activity	the name of activity
activity_alias	A string containing the name of the activity to be shown on the graph.
start	The start day (in "%Y-%m-%d" format).
end	The end day (in "%Y-%m-%d" format).
save	if NULL, the image is not saved. Otherwise, this parameter will be the name of the saved image. it should contain the path and name without the extension.

**Value**

None

## Examples

```
data("df516b_2")
df <- df516b_2
activity <- names(df)[2]
start <- "2020-05-01" # year-month-day
end <- "2020-08-13" # year-month-day
activity_alias <- "Motion Index"
my_daa <- daily_average_activity(df, activity, activity_alias, start, end,
  save = NULL
)
print(my_daa)
```

---

df516b\_2

*df516b\_2 Activity Data Sets*

---

## Description

A dataset containing the Motion index and steps count of a cow. The data set is sampled with 15 minutes samples. The data is as follows:

## Usage

```
df516b_2
```

## Format

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**Motion.Index** The motion index of the cow during the time sample

**Steps** The number of steps during the time sample

## Source

Agroscope Tanikon

---

df603

*df603 Activity Data Sets*

---

### Description

A dataset containing the x and y acceleration from an accelerometer installed on a cattle. There are missing days in this dataset. The data set is sampled with 15 minutes samples. The data is as follows:

### Usage

df603

### Format

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**move\_x** The acceleration along the x axis

**move\_y** The acceleration along the y axis

### Source

Agroscope Posieux

---

df625

*df625 Activity Data Sets*

---

### Description

A dataset containing the x and y acceleration from an accelerometer installed on a cattle. There are missing days in this dataset. The data set is sampled with 15 minutes samples. The data is as follows:

### Usage

df625

### Format

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**move\_x** The acceleration along the x axis

**move\_y** The acceleration along the y axis

**Source**

Agroscope Posieux

---

df678\_2

*df678\_2 Activity Data Sets*

---

**Description**

A dataset containing the Motion index and steps count of a cow. The data set is sampled with 15 minutes samples. The data is as follows:

**Usage**

df678\_2

**Format**

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**Motion.Index** The motion index of the cow during the time sample

**Steps** The number of steps during the time sample

**Source**

Agroscope Tanikon

---

df689b\_3

*df689b\_3 Activity Data Sets*

---

**Description**

A dataset containing the Motion index and steps count of a cow. The data set is sampled with 15 minutes samples. The data is as follows:

**Usage**

df689b\_3

**Format**

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**Motion.Index** The motion index of the cow during the time sample

**Steps** The number of steps during the time sample

**Source**

Agroscope Tanikon

---

df691b\_1

*df691b\_1 Activity Data Sets*

---

**Description**

A dataset containing the Motion index and steps count of a cow. The data set is sampled with 15 minutes samples. The data is as follows:

**Usage**

df691b\_1

**Format**

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**Motion.Index** The motion index of the cow during the time sample

**Steps** The number of steps during the time sample

**Source**

Agroscope Tanikon

---

df759a\_3

*df759a\_3 Activity Data Sets*

---

**Description**

A dataset containing the Motion index and steps count of a cow. The data set is sampled with 15 minutes samples. The data is as follows:

**Usage**

df759a\_3

**Format**

A data frame of 3 columns

**datetime** a POSIX formatted datetime

**Motion.Index** The motion index of the cow during the time sample

**Steps** The number of steps during the time sample



**Source**

Agroscope Tanikon

---

dfc	<i>Computes the Degree of Function coupling (DFC), Harmonic Part (HP) and Weekly Lomb-Scargle Spectrum (LSP Spec) for one variable in an activity dataset. The dataset should be digiRhythm friendly.</i>
-----	---

---

**Description**

The computation of DFC/HP/LSP parameters is done using a rolling window. If the rolling window is 7 days, first, we compute the parameters of Days 1-7 then, of days 2-8 and so on). For each window of the 7 days, the function will compute the LSP spectrum to determine the power of each frequency. Using Baluev (2008), we will compute the significance of the amplitude of each frequency component and determine whether it is significant or not. Then, we will have all the significant frequencies, whose amplitudes' summation will be denominated as SUMSIG. Among all the available frequencies, some are harmonic (those that correspond to waves of period 24h, 12h, 24h/3, 24h/4, ...). As a result, we will have frequency components that are significant and harmonic, whose powers' summation is called SSH (sum significant and harmonic). The summation of all frequency components up to a frequency reflecting a 24h period is called SUMALL. Therefore, DFC and HP are computed as follows:

**Usage**

```
dfc(
  data,
  activity,
  sampling = 15,
  alpha = 0.05,
  harm_cutoff = 12,
  rolling_window = 7,
  plot = TRUE,
  plot_harmonic_part = TRUE,
  verbose = TRUE,
  plot_lsp = TRUE
)
```

**Arguments**

data	The activity data set.
activity	The name of the activity.
sampling	The sampling period of the data set in minutes. the Lomb Scargle Periodogram is computed.
alpha	The significance level that should be used to determine the significant frequency component.

harm\_cutoff      the order of the highest harmonic needed to be considered. An integer equal to 1, 2, 3, ... Default is 12.

rolling\_window    The rolling window used to compute the LSP. Default is 7 days.

plot              if TRUE, the DFC/HP plot will be shown.

plot\_harmonic\_part  
                  if TRUE, it shows the harmonic part in the DFC plot

verbose            if TRUE, print weekly progress.

plot\_lsp          if TRUE, the LSP of each sliding week will be plotted

### Details

```
DFC <- SSH / SUMSIG HP <- SSH / SUMALL
```

### Value

A list containing 2 dataframe. DFC dataframe that contain the results of a DFC computation and SPEC Dataframe that contains the result of spectrum computation. The DFC contains 3 columns: \*\* The date in format YYYY-MM-DD. \*\* The DFC computed using a @rolling\_window days. \*\* The Harmonic Part (ratio). Data are supposed to sampled with a specific smpling rate. It should be the same sampling rate as in the given argument @sampling Missing days are not permitted. If you have data with half day, it should be removed.

### Examples

```
sampling_period <- 15 * 60 # seconds
two_weeks <- 2 * 7 * 24 * 60 * 60 # seconds
amplitude_24h <- 5
amplitude_12h <- 3
noise_sd <- 2
time_seq <- seq(0, two_weeks, by = sampling_period)
time_posix <- as.POSIXct(time_seq, origin = "1970-01-01")
sine_24h <- amplitude_24h * sin(2 * pi * time_seq / (24 * 60 * 60))
sine_12h <- amplitude_12h * sin(2 * pi * time_seq / (12 * 60 * 60))
noise <- rnorm(length(time_seq), mean = 0, sd = noise_sd)
data <- sine_24h + sine_12h + noise
df <- data.frame(time = time_posix, value = data)
names(df) <- c("datetime", "activity")
print(str(df))
my_lsp <- dfc(df, "activity", alpha = 0.05, harm_cutoff = 12, plot = TRUE)
```

---

df\_act\_info

*Outputs some information about the activity dataframe*

---

### Description

Outputs some information about the activity dataframe

**Usage**

```
df_act_info(df)
```

**Arguments**

df                    The dataframe containing the activity data

**Value**

No return value. Prints the head and tail as well as the starting and end date of a digiRhythm friendly dataframe.

---

dgm\_periodicity                    *Returns the periodicity of a digiRhythm dataframe*

---

**Description**

Returns the periodicity of a digiRhythm dataframe

**Usage**

```
dgm_periodicity(data)
```

**Arguments**

data                    a digiRhythm friendly dataframe

**Value**

returns a periodicity object of type xts.

**Examples**

```
data("df516b_2", package = "digiRhythm")
df <- df516b_2
dgm_periodicity(df)
```

---

**diurnality***Computes the diurnality index based on an activity dataframe*

---

**Description**

Computes the diurnality index based on an activity dataframe

**Usage**

```
diurnality(  
  data,  
  activity,  
  day_time = c("06:30:00", "16:30:00"),  
  night_time = c("18:00:00", "T05:00:00"),  
  save = NULL  
)
```

**Arguments**

<code>data</code>	a digiRhythm-friendly dataset
<code>activity</code>	The number of non-useful lines to skip (lines to header)
<code>day_time</code>	an array containing the start and end of the day period. Default: c("06:30:00", "16:30:00").
<code>night_time</code>	an array containing the start and end of the night period. Default: c("18:00:00", "T05:00:00").
<code>save</code>	if NULL, the image is not saved. Otherwise, this parameter will be the name of the saved image. it should contain the path and name without the extension.

**Value**

A ggplot2 object that contains the diurnality plot in addition to a dataframe with 2 col: date and diurnality index

**Examples**

```
data("df516b_2", package = "digiRhythm")  
data <- df516b_2  
data <- remove_activity_outliers(data)  
activity <- names(data)[2]  
d_index <- diurnality(data, activity)
```

---

`diurnality_customTimes`

*Computes the diurnality index, using different start and end definitions for each day and night, based on an activity dataframe*

---

### Description

Computes the diurnality index, using different start and end definitions for each day and night, based on an activity dataframe

### Usage

```
diurnality_customTimes(data, activity, timedata, save = NULL)
```

### Arguments

<code>data</code>	a digiRhythm-friendly dataset
<code>activity</code>	The number of non-useful lines to skip (lines to header)
<code>timedata</code>	a dataset, including 4 columns of POSIXct format, including date and time "day_start", "day_end", "night_start", "night_end"
<code>save</code>	if NULL, the image is not saved. Otherwise, this parameter will be the name of the saved image. it should contain the path and name without the extension.

### Value

A ggplot2 object that contains the Sliding diurnality plot in addition to a dataframe with 2 col: date and sliding diurnality index

### Examples

```
data("df516b_2", package = "digiRhythm")
data <- df516b_2
data <- remove_activity_outliers(data)
activity <- names(data)[2]
data("timedata", package = "digiRhythm")
timedata <- timedata
d_index <- diurnality_customTimes(data, activity, timedata)
```

---

highest\_possible\_harm\_cutoff

*Function to calculate the smallest possible harmonic to consider given a sampling frequency. The minimum possible harmonic = 2 x the period of the maximum frequency according to the Shanon theorem. Example: if the sampling period is 15 min, the minimum possible treatable period is 30 minutes and that corresponds to the 48th harmonic (24 hours \* 60 minutes / 48 = 30 minutes)*

---

### Description

Function to calculate the smallest possible harmonic to consider given a sampling frequency. The minimum possible harmonic = 2 x the period of the maximum frequency according to the Shanon theorem. Example: if the sampling period is 15 min, the minimum possible treatable period is 30 minutes and that corresponds to the 48th harmonic (24 hours \* 60 minutes / 48 = 30 minutes)

### Usage

```
highest_possible_harm_cutoff(sampling_period_in_minutes)
```

### Arguments

```
sampling_period_in_minutes
    The sampling period of the acquired data in minutes
```

### Value

Returns the smallest possible harmonic (of 24 hours) to consider given a sampling frequency.

---

import\_raw\_activity\_data

*Reads Raw Activity Data from csv files*

---

### Description

Reads Activity Data (data, time, activity(ies)) from a CSV file where we can skip some lines (usually representing the metadata) and select specific activities.

### Usage

```
import_raw_activity_data(
  filename,
  skiplines = 0,
  act.cols.names = c("Date", "Time", "Motion Index", "Steps"),
  date_format = "%d.%m.%Y",
  time_format = "%H:%M:%S",
```

```

    sep = ",",
    original_tz = "CET",
    target_tz = "CET",
    sampling = 15,
    trim_first_day = TRUE,
    trim_middle_days = TRUE,
    trim_last_day = TRUE,
    verbose = FALSE
  )

```

### Arguments

filename	The file name (full or relative path with extension)
skipLines	The number of non-useful lines to skip (lines to header)
act.cols.names	A vector containing the names of columns to read (specific to the activity columns)
date_format	The POSIX format of the Date column (or first column)
time_format	The POSIX format of the Time column (or second column)
sep	The delimiter/separator between the columns
original_tz	The time zone with which the datetime are encoded
target_tz	The time zone with which you want to process the data. Setting this argument to 'GMT' will help you coping with daylight saving time where changes occur two time a year.
sampling	The sampling frequency in minutes (default 15 min)
trim_first_day	if True, removes the data from the first day if it contains less than 80% of the expected data points.
trim_middle_days	if True, removes the data from the MIDDLE days if they contain less than 80% of the expected data points.
trim_last_day	if True, removes the data from the last day if it contains less than 80% of the expected data points.
verbose	print out some useful information during the execution of the function

### Details

This function prepare the data stored in a csv to be compatible with the digiRhythm package. You have the possibility to skip the first lines and choose which columns to read. You also have the possibility to sample the data. You can also choose whether to remove partial days (where no data over a full day is present) by trimming last, middle or last days. This function expects that the first and second columns are respectively date and time where the format should be mentioned.

```

file <- file.path('data', 'sample_data') colstoread <- c("Date", "Time", "Motion Index", 'Steps')
#The columns that we are interested in data <- improt_raw_icetag_data(filename = file, skipLines =
7, act.cols.names = colstoread, sampling = 15, verbose = TRUE)

```

### Value

A dataframe with datetime column and other activity columns, ready to be used with other functions in digirhythm

**Examples**

```
filename <- system.file("extdata", "sample_data.csv", package = "digiRhythm")
data <- import_raw_activity_data(
  filename,
  skipLines = 7,
  act.cols.names = c("Date", "Time", "Motion Index", "Steps"),
  sep = ",",
  original_tz = "CET",
  target_tz = "CET",
  date_format = "%d.%m.%Y",
  time_format = "%H:%M:%S",
  sampling = 15,
  trim_first_day = TRUE,
  trim_middle_days = TRUE,
  trim_last_day = TRUE,
  verbose = TRUE
)
print(head(data))
```

---

is\_dgm\_friendly

*Informs if a dataset is digiRhythm Friendly*


---

**Description**

Takes an activity dataset as input and gives information about 1) If a dataset is digiRhythm friendly, i.e., the functions used can work with this dataset and 2) Tells what's wrong, if any.

**Usage**

```
is_dgm_friendly(data, verbose = FALSE)
```

**Arguments**

data	The dataframe containing the activity data
verbose	if TRUE, prints info about the dataset

**Value**

Boolean. If True, the dataframe is digirhythm friendly. If False, the dataframe is not digirhythm friendly.

**Examples**

```
data("df516b_2", package = "digiRhythm")
d <- df516b_2
is_dgm_friendly(data = d, verbose = TRUE)
```



---

levopt	Returns the level given the p-value computed with paluev (2008). Copied from the LOMB library.
--------	--

---

### Description

Returns the level given the p-value computed with paluev (2008). Copied from the LOMB library.

### Usage

```
levopt(Z, alpha, fmax, tm)
```

### Arguments

Z	the power of the frequency
alpha	the significance level
fmax	the maximum frequency in the spectrum
tm	the time grid of the original time series

### Value

Returns the level given the p-value computed with paluev (2008).

---

lomb\_scargle\_periodogram

*Computes the Lomb Scargle Periodogram and returns the information needed for computing the DFC and HP. A plot visualizing the Harmonic Frequencies presence in the spectrum is possible. The function is inspired from the Lomb library in a great part, with modifications to fit the requirements of harmonic powers and computation of the DFC. This function is inspired by the lsp function from the lomb package and adapted to add different colors for harmonic and non harmonic frequencies in the signal. For more information about lomb::lsp, please refer to: <https://cran.r-project.org/web/packages/lomb/>*

---

### Description

Computes the Lomb Scargle Periodogram and returns the information needed for computing the DFC and HP. A plot visualizing the Harmonic Frequencies presence in the spectrum is possible. The function is inspired from the Lomb library in a great part, with modifications to fit the requirements of harmonic powers and computation of the DFC. This function is inspired by the lsp function from the lomb package and adapted to add different colors for harmonic and non harmonic frequencies in the signal. For more information about lomb::lsp, please refer to: <https://cran.r-project.org/web/packages/lomb/>

**Usage**

```
lomb_scargle_periodogram(
  data,
  alpha = 0.01,
  harm_cutoff = 12,
  sampling = 15,
  plot = TRUE,
  extra_info_plot = TRUE
)
```

**Arguments**

data	a digiRhythm friendly dataframe of only two columns
alpha	the statistical significance for the false alarm
harm_cutoff	the order of the highest harmonic needed to be considered. An integer equal to 1, 2, 3, ... Default is 12.
sampling	the sampling period in minutes. default = 15 min.
plot	if TRUE, the LSP will be plotted
extra_info_plot	if True, extra information will be shown on the plot

**Value**

a list that contains a dataframe (detailed below), the significance level and significance (for the record). The dataframe contains the power the frequency, the frequency in HZ, the p values according to Baluev 2008, the period that corresponds to the frequency in seconds and in hours and finally, a boolean to tell whether the frequency is harmonic or not.

**Examples**

```
data("df516b_2", package = "digiRhythm")
data <- df516b_2[1:672, c(1, 2)]
lomb_scargle_periodogram(data, alpha = 0.01, harm_cutof = 12, plot = TRUE)
```

---

paluev	<i>Returns p-value of a frequency peak according to paluev (2008) given Z, fmax and tm. Reused from the LOMB library (<a href="https://rdr.io/cran/lomb/">https://rdr.io/cran/lomb/</a>)</i>
--------	--

---

**Description**

Returns p-value of a frequency peak according to paluev (2008) given Z, fmax and tm. Reused from the LOMB library (<https://rdr.io/cran/lomb/>)

**Usage**

`pvaluev(Z, fmax, tm)`

**Arguments**

<code>Z</code>	the power of the frequency
<code>fmax</code>	the maximum frequency in the spectrum
<code>tm</code>	the time grid of the original time series

**Value**

an intermediate calculation step needed to compute the p-value according to `pvaluev` (2008).

---

<code>print_v</code>	<i>Print if Verbose is true</i>
----------------------	---------------------------------

---

**Description**

Print if Verbose is true

**Usage**

`print_v(string, verbose)`

**Arguments**

<code>string</code>	The string to print
<code>verbose</code>	if TRUE, print the string

**Value**

No return value. Prints the string concatenated with a verbose if the latter is not NULL.

---

remove\_activity\_outliers  
*Remove outliers from the data*

---

**Description**

Remove outliers from the data

**Usage**

```
remove_activity_outliers(df)
```

**Arguments**

df                    The dataframe containing the activity data

**Value**

return a dataframe where columns start the second one have undergone an outlier removal.

---

resample\_dgm            *Change the sampling of a digiRhythm friendly dataset*

---

**Description**

This function upsamples the data but does not downsample them. The new sampling should be a multiple of the current sampling period, and should be given in minutes.

**Usage**

```
resample_dgm(data, new_sampling)
```

**Arguments**

data                    The dataframe containing the activity data  
new\_sampling            The new sampling (multiple of current sampling) in minutes

**Value**

A digiRhythm friendly dataset with the new sampling

**Examples**

```
data("df516b_2", package = "digiRhythm")  
df <- df516b_2  
df <- remove_activity_outliers(df)  
new_sampling <- 30  
new_dgm <- resample_dgm(df, new_sampling)
```

---

timedata	<i>timedata Dataset of start and end of day and night</i>
----------	---

---

**Description**

A dataset of start and endtime of the morning milking and evening milking on a dairy farm.

**Usage**

timedata

**Format**

A data frame of 4 columns

**day\_start** a POSIX formatted datetime

**day\_end** a POSIX formatted datetime

**night\_start** a POSIX formatted datetime

**night\_end** a POSIX formatted datetime

**Source**

Johann Heinrich von Thünen- Institute of Organic Farming

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